

REMARKS

The Office Action dated January 24, 2007 has been received and carefully noted. The above amendments to the specification, claims, and the following remarks, are submitted as a full and complete response thereto.

The specification is amended to more clearly describe features recited in the present claims. Claims 31-39, 41, 42, 44, and 48-59 are amended to more particularly point out and distinctly claim the subject matter of the present invention. Claims 60-72 are cancelled without prejudice. New claims 73-75 are added. No new matter is added. Claims 31-59 and 73-75 are respectfully submitted for consideration.

The Office Action rejected claim 39 under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement.

Applicants respectfully submit that the specification on page 9 second paragraph contains a clear and concise description of the features recited in claim 39.

The Office Action rejected claim 40 under 35 U.S.C. 112, second paragraph as failing to comply with the written description requirement. Applicants respectfully submit that the present specification on page 9, second paragraph contains a clear and concise description of the features recited in claim 40.

The Office Action rejected claim 42 under 35 U.S.C. 112, second paragraph as failing to comply with the written description requirement. Applicants respectfully submit that the specification on page 3 last paragraph – page 4 first paragraph contains a clear and concise description of the features recited in claim 42. Specifically, complex

symbols may be rotated by a specific angle, and that this rotation may also be performed by a non-diagonal unitary matrix.

Based at least on the above, Applicants submit that the present specification complies with the written description requirement. Accordingly, withdrawal of the rejection under 35 U.S.C. 112, first paragraph is respectfully requested.

The Office Action rejected claim 31 under 35 U.S.C. 102(a) as being anticipated by US Patent No. 6,307,882 to Marzetta (Marzetta). The Office Action indicated that claim 53 is analyzed and rejected with respect to claim 31. Applicants respectfully submit that Marzetta fails to disclose or suggest all of the features recited in any of the pending claims.

As a preliminary matter, Applicants submit that claim 53 is rejected with respect to claim 34. However, independent claims 53, 57-59 are not properly indicated as being rejected in the Office Action. Thus, in the event that the present application is not in condition for allowance, Applicants request a new non-final Office Action that more clearly indicates which claims are being rejected and the basis for the rejections.

Claim 31, from which claims 32-52 depend, is directed to a method of transmitting complex symbols using a transmission code matrix. The transmission code matrix is constructed. The transmission code matrix, is transmitted at least partially in parallel, using substantially orthogonal signalling resources and at least three different transmit antenna paths. The transmission code matrix can be expressed as being constructed using at least two transformed transmit diversity code matrices. The transformed transmit

diversity code matrices can be expressed as being constructed by transforming at least two code matrices using linear transformations. Wherein the transmit diversity code matrices, at least one of which is of dimension greater than one, can be expressed as being formed by modulating at least two at least partially different streams of complex symbols that are obtainable from a single stream of complex symbols by conversion.

Claim 53, from which claims 54-56 depend, is directed to an apparatus for transmitting complex symbols using a transmission code matrix. Components are configured to construct a transmission code matrix out of complex symbols. A transmission unit is configured to transmit said transmission code matrix, at least partially in parallel, using substantially orthogonal signalling resources and at least three different transmit antenna paths. The transmission code matrix can be expressed as being constructed using at least two transformed transmit diversity code matrices. The transformed transmit diversity code matrices can be expressed as being constructed by transforming at least two transmit diversity code matrices using linear transformations. The transmit diversity code matrices, at least one of which is of dimension greater than one, can be expressed as being formed by modulating at least two at least partially different streams of complex symbols that are obtainable from a single stream of complex symbols by conversion.

Claim 57, is directed to a system comprising a transmitter for transmitting complex symbols using a transmission code matrix, and a receiver for receiving transmitted complex symbols. Components are configured to construct a transmission

code matrix out of complex symbols. A transmission unit is configured to transmit said transmission code matrix, at least partially in parallel, using substantially orthogonal signalling resources and at least three different transmit antenna paths. The transmission code matrix can be expressed as being constructed using at least two transformed transmit diversity code matrices. The transformed transmit diversity code matrices can be expressed as being constructed by transforming at least two transmit diversity code matrices using linear transformations. The transmit diversity code matrices, at least one of which is of dimension greater than one, can be expressed as being formed by modulating at least two at least partially different streams of complex symbols that are obtainable from a single stream of complex symbols by conversion.

Claim 58, from which claim 59 depends, is directed to a transmission code matrix, which is to be transmitted at least partially in parallel on at least three different transmit antenna paths using substantially orthogonal signalling resources. The transmission code matrix can be expressed as being constructed using at least two transformed transmit diversity code matrices. The transformed transmit diversity code matrices can be expressed as being constructed by transforming at least two transmit diversity code matrices using linear transformations. The transmit diversity code matrices, at least one of which is of dimension greater than one, can be expressed as being formed by modulating at least two at least partially different streams of complex symbols that are obtainable from a single stream of complex symbols by conversion.

The present invention is related to a method of transmitting complex symbols using a transmission code matrix. The method comprises constructing said transmission code matrix, wherein each of said complex symbols forms part of at least two elements of said transmission code matrix and wherein at least some of said matrix elements are formed by linearly mixing at least two of said complex symbols. The method further comprises transmitting said transmission code matrix, at least partially in parallel, using substantially orthogonal signaling resources and at least three different transmit antenna paths. Applicants submit that claims 31, 53 and 57-59 recite features that are neither disclosed nor suggested by Marzetta.

Marzetta is related to a system where training signals are transmitted from the transmit antenna elements of a transmitter to the receive antenna elements of a receiver in a determined sequence during a defined training signal time interval, and signals corresponding to the training signals are received via the receive antenna elements (see abstract and Fig. 1). Therein, the training signal sent to transmit antenna $m=1,...,M$ at time instance $t=1,...,T$ is denoted as s_{tm} , and these s_{tm} are arranged in a $T \times M$ matrix S (see col. 3, lines 34-36 and eq. 2). To ensure that the $M \times M$ matrix $S^H S$ is non-singular and well-conditioned to allow for channel estimation at the receiver, it is proposed that the rows of S are orthogonal. Examples therefore are given in Eq. 12, where each row only has one non-zero entry, or in col. 6, lines 13-21, where the use of Fourier signals is proposed.

Applicants submit that Marzetta fails to disclose or suggest at least the features of wherein said transmission code matrix can be expressed as being constructed using at

least two transformed transmit diversity code matrices, wherein said transformed transmit diversity code matrices can be expressed as being constructed by transforming at least two code matrices using linear transformations, as recited in claim 31. Marzetta fails to mention, disclose or suggest a matrix S in which each of a plurality of complex symbols would form part of at least two elements of the matrix S , and wherein at least some of the matrix elements would be formed by linearly mixing at least two of said complex symbols.

Based at least on the above, Applicants respectfully submit that Marzetta fails to disclose or suggest all of the features recited in claim 31, 53 and 57-59. Accordingly, withdrawal of the rejection under 35 U.S.C. 102(a) is respectfully requested.

The Office Action rejected claims 32-38 under 35 U.S.C. 103(a) as being obvious over Marzetta, in view of US Patent No. 6,925,131 to Balakrishnan et al. (Balakrishnan). The Office Action took the position that Marzetta disclosed most of the features of these claims except converting a stream of complex symbols to at least two partially different streams of complex symbols, modulating the at least two streams of complex symbols to form at least two code matrices, transforming transmit diversity code matrices and transmitting diversity code matrices. The Office Action asserted that Balakrishnan discloses these features. Applicants submit that the cited references taken individually or in combination, fail to disclose or suggest all of the features of any of the pending claims. Specifically, Marzetta is deficient at least for the same reasons discussed above regarding claim 31 and Balakrishnan fails to cure these deficiencies.

Marzetta is discussed above. Balakrishnan is related to a method and system for increasing the data rate of a multiple-input and/or multiple output system that has frequency-selective fading by using training sequences with both low normalized auto-correlation and low normalized cross-correlation. With reference to Fig. 1, it is disclosed that a primitive data stream 115 is divided into a plurality of sub-streams 125-1 .. 125-3 typically by demultiplexing. The sub-streams are processed, typically encoded and modulated onto a carrier signal in encoder/modulators 135-1 .. 135-3, respectively, and then transmitted over antennas 105-1 .. 105-3 (see col. 3, line 43- col. 4, line. 7).

However, Balakrishnan fails to disclose or suggest wherein said transmission code matrix can be expressed as being constructed using at least two transformed transmit diversity code matrices, wherein said transformed transmit diversity code matrices can be expressed as being constructed by transforming at least two code matrices using linear transformations, as recited in claim 31, 53, 57 and 59. Balakrishnan, in col. 3, line 52 to col. 4, line 7 merely describes that a data stream is divided into a plurality of sub-streams, which are then encoded and modulated onto a carrier signal and then transmitted over a plurality of antennas. Balakrishnan is silent with regards to the symbols of the sub-streams being arranged in transmit diversity matrices (i.e. matrices, in which at least some symbols are transmitted by more than one transmit antenna). Balakrishnan merely discloses that the primitive data stream is demultiplexed into sub-streams, which is generally understood in a way that the sub-streams do not share symbols, and that these mutually different sub-streams are transmitted from different antennas, respectively, so

that there is no transmit diversity at all. Thus, Balakrishnan fails to cure the deficiencies of Marzetta.

Based at least on the above, Applicants submit that the cited references fail to disclose or suggest all of the features of claim 32. Withdrawal of the rejection under 35 U.S.C. 103(a) is respectfully requested.

The Office Action rejected claims 41 and 49-51 under 35 U.S.C. 103(a) as being obvious over Marzetta and Balakrishnan, in further view of US Patent No. 5,701,333 to Okanou et al. (Okanou). The Office Action took the position that Marzetta and Balakrishnan disclosed most of the features of these claims except serial-to-parallel conversion. The Office Action relied on Okanou to disclose this feature. Applicants respectfully submit that the cited references, individually or in combination, fail to disclose or suggest all of the features of any of the pending claims. Specifically, Marzetta and Balakrishnan are deficient at least for the reasons discussed above and Okanou fails to cure these deficiencies.

Marzetta and Balakrishnan are discussed above. Okanou is directed to a diversity receiver, which, comprises serial-to-parallel conversion units 58 and 59 (see Fig. 3). However, Okanou fails to disclose or suggest at least the features of wherein said transmission code matrix can be expressed as being constructed using at least two transformed transmit diversity code matrices, wherein said transformed transmit diversity code matrices can be expressed as being constructed by transforming at least two code matrices using linear transformations, and wherein said transmit diversity code matrices,

at least one of which is of dimension greater than one, can be expressed as being formed by modulating at least two at least partially different streams of complex symbols that are obtainable from a single stream of complex symbols by conversion. Thus, Okanou fails to cure the deficiencies of Marzetta and Balakrishnan.

Based at least on the above, Applicants submit that the cited references fail to disclose or suggest all of the features of claim 41. Accordingly, withdrawal of the rejection under 35 U.S.C. 103(a) is respectfully requested.

Claim 52 is rejected under 35 U.S.C. 103(a) as being obvious over Marzetta and Balakrishnan, in further view of US Patent No. 6356,555 to Rakib et al. (Rakib). The Office Action took the position that Marzetta and Balakrishnan disclosed most of the features of these claims except non-overlapping time slots, different spreading codes, different OFDM sub carriers, different wavelet waveforms and different FDMA channels. The Office Action asserted that Rakib disclosed these features. Applicants submit that the cited references, taken individually or in combination, fail to disclose or suggest all of the features of claim 52. Specifically, Marzetta and Balakrishnan are deficient at least for the same reasons discussed above, and Rakib fails to cure these deficiencies.

Marzetta and Balakrishnan are discussed above. Rakib is directed to carrying out synchronous code division multiple access (SCDMA) communication of multiple channels of digital data over a shared transmission medium. However, Applicants submit that Rakib fails to disclose or suggest at least the features of the transmission code matrix can be expressed as being constructed using at least two transformed transmit diversity

code matrices, wherein said transformed transmit diversity code matrices can be expressed as being constructed by transforming at least two code matrices using linear transformations. Thus, Rakib fails to cure the deficiencies of Marzetta and Balakrishnan.

Based at least on the above, Applicants respectfully submit that the cited references fail to disclose or suggest all of the features of claim 52. Accordingly, withdrawal of the rejection under 35 U.S.C. 103(a) is respectfully requested.

The Office Action rejected claims 59 and 60 under 35 U.S.C. 103(a) as being obvious over Marzetta, in view of US Patent No. 6,661,856 to Calderbank et al. (Calderbank). The Office Action took the position that Marzetta disclosed most of the features of these claims except four complex signals and wherein the transmission code matrix comprises 4 times 4 elements. The Office Action asserted that Calderbank disclosed these features. Applicants respectfully submit that the cited references, taken individually or in combination fail to disclose or suggest all of the features of any of the pending claims. Specifically, Marzetta is deficient at least for the reasons discussed above and Calderbank fails to cure these deficiencies. The rejection of claim 60 is moot in light of the cancellation of this claim.

Marzetta is discussed above. Calderbank is directed to wireless communication, particularly, to techniques for effective wireless communication in the presence of fading and other degradations. According to Fig. 1 and the corresponding description in col. 3, 1.36-58, a sequence of symbols $c_1, c_2, c_3, \dots, c_6$ is transmitted via n transmitter antennas 11-1 .. 11- n as defined by the transmit diversity matrix of eq. (1), where the columns of

this matrix represent antennas, and the rows represent the time of transmission. Furthermore, two matrices providing a rate of 0.75 for $n=3$ and $n=4$ are disclosed in eq. (27) and (28) of Calderbank (see col. 10 of Calderbank).

Applicants respectfully submit that the cited references fail to disclose or suggest at least the features of the transmission code matrix can be expressed as being constructed using at least two transformed transmit diversity code matrices, wherein said transformed transmit diversity code matrices can be expressed as being constructed by transforming at least two code matrices using linear transformations. Calderbank merely discloses complex symbols c_1 , c_2 and c_3 , which are transmitted partially in parallel, using substantially orthogonal signalling resources.

Based at least on the above, Applicants submit that the cited references fail to disclose or suggest all of the features of claim 59. Accordingly, withdrawal of the rejection under 35 U.S.C. 103(a) is respectfully requested.

As discussed above, new claims 73-75 are added. Applicants submit that claims 73-75 recite features that are neither disclosed nor suggested in the cited references.

Applicants submit that each of claims 31-59 and 73-75 recites features that are neither disclosed nor suggested in any of the cited references. Accordingly, it is respectfully requested that each of claims 31-59 and 73-75 be allowed, and this application passed to issue.

If for any reason the Examiner determines that the application is not now in condition for allowance, it is respectfully requested that the Examiner contact, by

telephone, the applicants' undersigned attorney at the indicated telephone number to arrange for an interview to expedite the disposition of this application.

In the event this paper is not being timely filed, the applicants respectfully petition for an appropriate extension of time. Any fees for such an extension together with any additional fees may be charged to Counsel's Deposit Account 50-2222.

Respectfully submitted,



David E. Brown
Registration No. 51,091

Customer No. 32294
SQUIRE, SANDERS & DEMPSEY LLP
14TH Floor
8000 Towers Crescent Drive
Tysons Corner, Virginia 22182-2700
Telephone: 703-720-7800
Fax: 703-720-7802

DEB:jkm